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Gold-Thiol Nano-particles in Thin Liquid Films

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Beamline: X22B

Introduction: The physical properties of thin liquid films are in the focus of both of technological applications (coating, lubrication, adhesion) and statistical physics [1]. Understanding the behavior of nano-objects in thin liquid film is important step toward manipulation of them as well as controllable delivery.
Methods and Materials: We study the structure of silicon deposited densely packed 2-dimensional monolayer of ~ 3nm nano-particles Au-S$(CH_2)_{13}CH_3$) by adsorbing liquid cyclohexane. We control the thickness of the adsorbed liquid layer [2] by changing the chemical potential of cyclohexane vapor relative to its liquid reservoir through temperature differences ΔT with accuracy ~1mK.
Results: X-ray reflectivity [3] and Grazing Incidence Diffraction were applied to measure the changes in the nano-particles monolayer during the controllable adsorption. The normalized x-ray reflectivities (R/R_F) on the Fig. 1 (left) and the corresponded electron profiles (rigth) illustrate the evolution the surface layer. The preliminary analysis of the data suggests a scenario, where a dry monolayer (black) develops into the well defined bilayer of nano-particles (green), with following continuous transition (blue and red) to uniform layer with disordered nano-particles (purple). GID data (not shown) confirms this interpretation. The process is completely reversible, and the uniform monolayer is observed upon drying.
Conclusions: We observed the changes of the nano-particle structure all the way from a completely dry solid monolayer to complete dissolution in thin fluid film.

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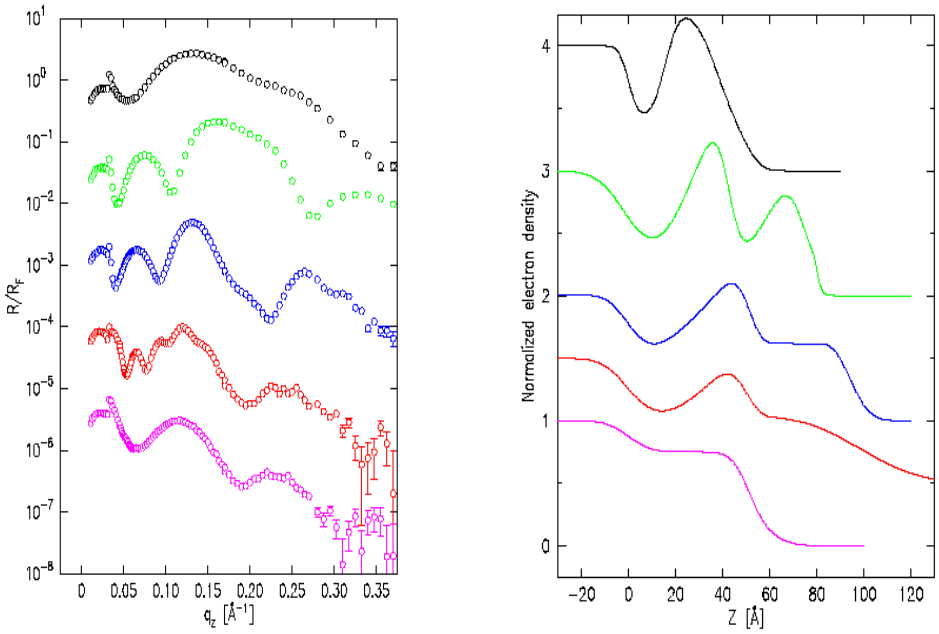

Fig. 1. (Left) Specular reflectivity data for different liquid adsorption. The top is the dry Schaefer monolayer and liquid adsorption increases for the lower traces. (Right) The density profiles corresponding to the traces in the left panel. The various peaks indicate layers of gold particles.